

1. A process for incorporating a metal salt of an antimicrobial onto an outer surface of, or into a porous inner portion of, an extruded or molded plastic product which comprises the steps of:

5 (a) extruding or molding a metal-containing plastic-forming composition in an extruder or a mold at an elevated temperature to provide a metal-containing extruded or molded product,

10 (b) contacting the extruded or molded product from step (a) with an aqueous solution of a water-soluble biocide in order to cause the water soluble biocide to react or chelate with at least a portion of the metal on an outer surface, or in a porous inner portion, of the warm extruded or molded product, thereby forming an

15 antimicrobially protected plastic product having a water-insoluble metal salt of a biocide on the surface, and/or in the porous inner portion, thereof.

2. The process of claim 1 wherein the water-soluble biocide is selected from the group consisting of pyrithiones, 2-hydroxypyridine N-oxide, N-nitroso-N-cyclohexyl hydroxylamine, 8-hydroxyquinoline,

thiocarbamates, dithiocarbamates, and combinations thereof.

3. The process of claim 1 wherein the water-
5 soluble biocide is a pyrithione selected from the group consisting of pyrithione acid, sodium pyrithione, potassium pyrithione, pyrithione disulfide magnesium sulfate, and combinations thereof.

10 4. The process of claim 1 wherein the metal is selected from the group consisting of calcium, zinc, iron, copper, silver, titanium, manganese, and combinations thereof.

15 5. The process of claim 1 wherein the metal is present as an oxide, hydroxide, carbonate, borate, silicate, chloride, sulfate, stearate, laurate, or combination thereof.

20 6. The process of claim 4 wherein the metal is present on the surface, and/or in the porous interior portion, of the extruded product in an amount of from about 0.01 g/m² to about 20 g/m² based upon the outer

surface area, or porous interior portion, of the extruded or molded plastic product.

7. The process of claim 4 wherein the metal is
5 calcium, and the calcium is present on the surface of or in the porous structure of the extruded product, in an amount of from about 0.01 g/m^2 to 100 g/m^2 based upon the surface area of the extruded plastic.

10 8. The process of claim 4 wherein the metal is zinc, and the zinc is present on the surface of, or in the porous interior portion of the molded or extruded product, in an amount of from about 0.01 g/m^2 to about 20 g/m^2 based upon the surface area of the plastic
15 structure.

9. The process of claim 1 where the water-insoluble metal biocide has a water solubility of 0.05 mg/L to 10 g/L .

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10. The process of claim 1 where the water-insoluble metal biocide has a water solubility of 0.05 mg/L to 1000 mg/L .

11. The process of claim 1 where the water-insoluble metal biocide has a water solubility of 0.05 mg/L to 100 mg/L.

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12. The process of claim 1 where the water-insoluble metal biocide has a surface concentration of about 0.01 g/m² to about 20 g/m² based upon the total surface area of the extruded or molded plastic product.

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13. The process of claim 1 where the plastic-forming composition comprises a virgin or recycled resin suitable for extruding or molding selected from the group consisting of virgin or recycled polyethylene, 15 polypropylene, polyallomer, polyacetal, polyamide, polyester, polystyrene, polycarbonate, polyurethane, acrylonitrile-butadiene-styrene ("ABS"), polyvinylchloride, polyvinylfluoride, ethyl-vinyl acetate co-polymer, and combinations thereof.

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14. The process of claim 13 wherein the polyethylene is virgin or recycled selected from the group

consisting of low density polyethylene ("LDPE"), high density polyethylene ("HDPE"), and combinations thereof.

15. The process of claim 1 where the molded or extruded plastic product or plastic-forming composition 5 additionally comprises at least one cellulosic filler selected from the group consisting of wood chips, wood fibers, wood flour, wood dust, newspaper, rice hulls, straw, peanut shells, alfalfa, cotton, jute and combinations thereof.

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16. The process of claim 1 wherein the molded or extruded plastic product or plastic-forming composition additionally comprises reinforcing fibers selected from the group consisting of glass fibers, carbon fibers, 15 polyester fibers, nylon and aramid fibers, cellulosic fibers and combinations thereof, thereby providing a reinforced plastic product.

17. An antimicrobially protected, metal-containing 20 plastic structure produced by reacting or chelating at least a portion of said metal with a water-soluble biocide to form a water-insoluble metal salt of biocide on an outer surface of the article, or into a porous

interior portion of the article, said water-insoluble metal salt of the biocide exhibiting a slow release rate of biocide from the surface or interior portion of the article, as compared to the release rate for the water-soluble biocide.

18. The plastic structure of claim 17 wherein the water-soluble biocide is selected from the group consisting of pyrithione, 2-hydroxypyridine N-oxide, N-
10 nitroso-N-cyclohexyl hydroxylamine, 8-hydroxyquinoline, thiocarbamates, dithiocarbamates, and combinations thereof.

19. The plastic structure of claim 17 wherein the water-soluble biocide is a pyrithione selected from the group consisting of pyrithione acid, sodium pyrithione, potassium pyrithione, pyrithione disulfide magnesium sulfate, and combinations thereof.

20. The plastic structure of claim 17 wherein the metal is selected from the group consisting of calcium, zinc, iron, copper, silver, titanium, manganese, and combinations thereof.

21. The plastic structure of claim 17 wherein the metal is present as an oxide, hydroxide, carbonate, borate, silicate, chloride, sulfate, stearate, laurate, 5 or combination thereof.

22. The plastic structure of claim 17 wherein the metal is present on the surface of the extruded or molded product, in an amount of from about 0.01 g/m^2 to about 20 10 g/m^2 or more, based upon the surface area of the extruded plastic.

23. The plastic structure of claim 17 wherein the metal is calcium, and the calcium is present on the 15 surface of or in the porous structure of the extruded product, in an amount of from about 0.01 g/m^2 to 100 g/m^2 based upon the surface area of the extruded plastic.

24. The plastic structure of claim 17 wherein the 20 metal is zinc, and the zinc is present on the surface of, or in the porous interior portion of the molded or extruded product, in an amount of from about 0.01 g/m^2 to

about 20 g/m² based upon the surface area of the plastic structure.

25. The plastic structure of claim 17 where the water-insoluble metal biocide has a water solubility of 5 0.05 mg/L to 10 g/L of water.

26. The plastic structure of claim 17 wherein the water-insoluble metal biocide has a water solubility of 0.05 mg/L to 1000 mg/L of water.

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27. The plastic structure of claim 17 wherein the water-insoluble metal biocide has a water solubility on the surface of the structure of from about 0.05 mg/L to 100 mg/L.

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28. The plastic structure of claim 17 wherein the water-insoluble metal biocide has a surface concentration of about 0.01 g/m² to about 20 g/m².

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29. The plastic structure of claim 17 wherein the plastic comprises a virgin or recycled resin suitable for extruding or molding such as polyethylene (e.g., low density polyethylene ("LDPE") or high density

polyethylene ("HDPE"), polypropylene, polyallomer,
polyacetal, polyamide, polyester, polystyrene,
polycarbonate, polyurethane, acrylonitrile-butadiene-
styrene ("ABS"), polyvinylchloride, polyvinylfluoride,
5 ethyl-vinyl acetate co-polymer, and combinations thereof.

30. The plastic structure of claim 17 which
additionally contains at least one cellulosic filler
selected from the group consisting of wood chips, wood
10 fibers, wood flour, wood dust or the like, newspaper,
rice hulls, straw, peanut shells, alfalfa, cotton, jute
and combinations thereof.

31. The plastic structure of claim 17 wherein the
15 plastic comprises a virgin or recycled resin suitable for
molding selected from the group consisting of a
polyester, a polyacrylate, and combinations thereof.

32. The plastic structure of claim 17 which
20 additionally comprises reinforcing fibers selected from
the group consisting of glass fibers, carbon fibers,
polyester fibers, nylon and aramid fibers, cellulosic
fibers and combinations thereof, and combinations

thereof, thereby providing a reinforced plastic structure.